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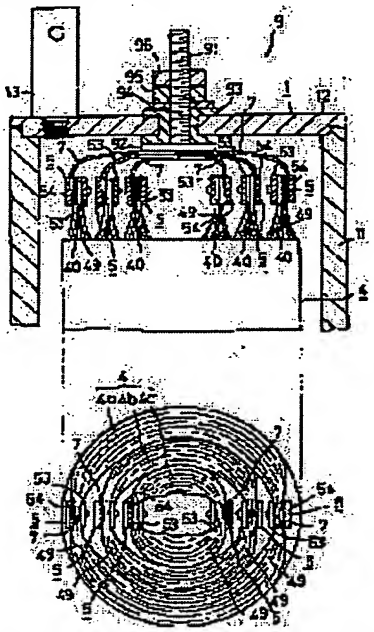
(54) CYLINDRICAL NONAQUEOUS ELECTROLYTIC SOLUTION SECONDARY BATTERY

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a cylindrical nonaqueous electrolytic solution secondary battery having lower internal resistance and better productivity than a conventional battery.
SOLUTION: In the cylindrical nonaqueous electrolytic solution secondary battery, a non-coated section which is a part of a core comprising a positive or negative electrode and is not coated by an active material, protrudes at an end of a winding electrode body 4 in the direction of an axis. A plurality of collector electrodes 5 are mounted on a protruding section. Each collector electrode 5 comprises a rivet 54 and a washer 53. The rivet 54 has a tabular head and a shaft. The shaft penetrates a non-coated core bundle 49, a reed 7 and the washer 53. An end of the shaft is narrowed. The non-coated core bundle 49 and the reed 7 are pressed between the tabular head and the washer 53. Each reed 7 is coupled to an electrode terminal 9.



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[Claim(s)]

[Claim 1] The rolling-up electrode object (4) which the separator (42) containing nonaqueous electrolyte was made to intervene between band-like positive electrodes (41) and negative electrodes (43), respectively, and rolled these round inside the cylinder-like cell can (1) at the curled form is contained. In the cylindrical nonaqueous electrolyte rechargeable battery which can take out the power which a positive electrode (41) and a negative electrode (43) apply an active material to the front face of a band-like axis, respectively, and are constituted, and a rolling-up electrode object (4) generates from the electrode terminal area of a couple to the exterior In one [at least] edge of the volume shaft orientations of a rolling-up electrode object (4) The axis non-coating section by which an active material is not applied to the axis which constitutes a positive electrode (41) or a negative electrode (43) A projection, This lobe is divided into two or more ring-like fields (4a) (4b) (4c). Each ring-like field is governed by the non-coating axis bundle (49) with the current collection terminal (5) in 1 of the hoop direction, or two or more places. Each current collection terminal (5) consists of the rivet members (54) and washer members (53) which have been arranged on both sides of a non-coating axis bundle (49) at both sides. The rivet member (54) has the plate-like head (51) and the shank (52). A shank (52) penetrates a non-coating axis bundle (49), a lead (7), and a washer member (53). The non-coating axis bundle (49) and the lead (7) are compressed by closing the point of this shank (52) between the plate-like head (51) of a rivet member (54), and a washer member (53). The cylindrical nonaqueous electrolyte rechargeable battery characterized by connecting each lead (7) with the electrode terminal area.

[Claim 2] Two or more current collection terminals (5) are cylindrical nonaqueous electrolyte rechargeable batteries according to claim 1 arranged in the location which carries out the abbreviation division-into-equal-parts rate of the die length when developing a curled form axis.

[Claim 3] Cylindrical to an apical surface or the cylindrical nonaqueous electrolyte rechargeable battery according to claim 1 or 2 with which the conic crevice (55) reduced toward the method of the back is formed of the shank (52) of the rivet member (54) which constitutes each current collection terminal (5).

[Detailed Description of the Invention]

[0001]

[Field of the Invention] The rolling-up electrode object used as a rechargeable battery element is held in the interior of a cell can, and this invention relates to the cylindrical nonaqueous electrolyte rechargeable battery which can roll round from the electrode terminal area of the couple prepared in the cell can, and can take out the generating power of an electrode object.

[0002]

[Description of the Prior Art] In recent years, the rechargeable lithium-ion battery with a high energy density attracts attention as a power source of pocket mold electronic equipment, an electric vehicle, etc. For example, as shown in drawing 4 and drawing 5 , inside the cell can (1) of the shape of a cylinder which carries out welding immobilization of a lid (12) and (12), and becomes at the both ends of a barrel (11), the comparatively big cylindrical rechargeable lithium-ion battery of capacity used for an electric vehicle holds the rolling-up electrode object (2) shown in drawing 6 , and is constituted. A style (9) and (9) are attached. both lids (12) and (12) -- the electrode edge of a positive/negative couple -- a cordless handset -- the power which two or more two poles of a rolling-up electrode object (2), two-electrodes terminal devices (9), and (9) are mutually connected by the electrode tab (3) of a book, respectively, and a rolling-up electrode object (2) generates -- the electrode edge of a couple -- a cordless handset -- it is possible to take out from a style (9) and (9) outside. Moreover, the gas exhaust valve (13) of a pressure closing motion type is attached in each lid (12).

[0003] The rolling-up electrode object (2) shown in drawing 6 makes a band-like separator (22) intervene between band-like positive electrodes (21) and negative electrodes (23), respectively, winds these around a curled form and is constituted. A positive electrode (21) applies the positive active material (24) which consists of a lithium multiple oxide to both sides of the band-like axis which consists of aluminium foil, and is constituted, and a negative electrode (23) applies the negative-electrode active material (25) containing a carbon material to both sides of the band-like axis which consists of copper foil, and is constituted. Impregnation of the nonaqueous electrolyte is carried out to the separator (22). The end face section of two or more electrode tabs (3) is joined to a positive electrode (21) and a negative electrode (23) by spot welding etc., respectively, and the point projects from the rolling-up electrode object (2). In addition, the electrode tab (3) joined to the positive electrode (21) is formed from aluminium foil, and the electrode tab (3) joined to the negative electrode (23) is formed from copper foil.

[0004] and it is shown in drawing 5 -- as -- the point (31) of two or more electrode tabs (3) with the same polarity -- one electrode edge -- a cordless handset -- it connects with the style (9). in addition, drawing 5 -- setting -- for convenience -- the point of some electrode tabs -- an electrode edge -- a cordless handset -- the condition of connecting with the style (9) -- being shown -- other electrode tabs -- a point -- an electrode edge -- a cordless handset -- the graphic display in the condition of connecting with the style (9) is omitted.

[0005] an electrode edge -- a cordless handset -- a style (9) is equipped with the electrode terminal (91) attached by penetrating the lid (12) of a cell can (1), and the flange (92) is formed in the end face section of this electrode terminal (91). The breakthrough of a lid (12) is equipped with an insulating member (93), and a lid (12), the electric insulation between electrode terminals (91), and seal nature are maintained. While a washer (94) is inserted in from the outside of a lid (12), the 1st nut (95) and the 2nd nut (96) are screwing in an electrode terminal (91). And seal nature is raised by binding the 1st nut (95) tight and compressing an insulating member (93) with the flange (92) and washer (94) of an electrode terminal (91). The point (31) of said electrode tab (3) which are books is being fixed to the flange (92) of an electrode terminal (91) by spot welding or ultrasonic welding.

[0006] By the way, in a rechargeable lithium-ion battery, since the die length of a positive electrode and a negative electrode becomes large with enlargement of a cell, with the current collection structure by the electrode tab like ****, current collection nature is low, dispersion occurs in internal resistance or the problem of discharge capacity falling arises.

[0007] Then, the **** current collection structure shown in drawing 7 is proposed in order to cover the overall length of a positive electrode and a negative electrode and to obtain uniform current collection nature. The positive electrode with which a rolling-up electrode object (4) comes to apply positive active material (44) on the surface of an axis (45) similarly in this current collection structure (41), Although it consists of separators (42) with which impregnation of the nonaqueous electrolyte was carried out to the negative electrode (43) which comes to apply a negative-electrode active material (46) on the surface of an axis (47) Respectively a positive electrode (41) and a negative electrode (43) are shifted crosswise, are piled up on a separator (42), and are rolled round by the curled form. By this, while the edge (48) of the axis (45) of a positive electrode (41) projects to the method of outside [edge / of a separator (42)] at one edge among the both ends of the volume shaft orientations of a rolling-up electrode object (4), in the other-end section, the edge (48) of the axis (47) of a negative electrode (43) projects to the method

of outside [edge / of a separator (42)]. and in the both ends of a rolling-up electrode object (4), a disc-like collecting electrode plate (32) welds with the edge (48) of the axis of positive/negative two poles, and (48), respectively -- having -- this collecting electrode plate (32) -- a lead member (33) -- minding -- said electrode edge -- a cordless handset -- it connects with a style (9).

[0008] However, in the nonaqueous electrolyte rechargeable battery which has the current collection structure shown in drawing 7 , since the area of the edge (48) of the axis (45) which constitutes the positive electrode (41) and negative electrode (43) of a rolling-up electrode object (4), and (47), and (48) was small, the touch area between the axis edge and a collecting electrode plate (32) was small, and there was a problem to which the internal resistance of a cell becomes large by this. Moreover, it is required to reduce internal resistance as much as possible, in order to obtain high power, and further, in order to be a manufacturing-cost cutback, the current collection structure excellent in productivity is needed.

[0009] Then, as shown in drawing 8 , the current collection structure which welds this bending section (64) by resistance to the axis edge (48) is proposed in the condition of having rolled round this collecting electrode plate (62) and having pushed against the axis edge (48) of an electrode object (4) using the collecting electrode plate (62) which formed two or more bending sections (64) in the plate-like body (63) (for example, refer to JP,11-31497,A).

[0010] Moreover, it replaces with a disc-like collecting electrode plate, as shown in drawing 9 , the current collection member (65) in which two or more slits (66) were cut is rolled round, and it installs in the edge of an electrode object (4), and in the condition of having made the axis edge (48) insert in the slit (66) of this current collection member (65), a laser beam is irradiated on the front face of a current collection member (65), and the current collection structure of performing laser welding is proposed (for example, refer to JP,10-261441,A).

[0011]

[Problem(s) to be Solved by the Invention] However, in the current collection structure which welds by resistance the collecting electrode plate which formed the bending section like drawing 8, when the thickness of an axis was very small like a rechargeable lithium-ion battery, not only welding is difficult, but the electric resistance in a weld zone was large, and there was a problem that the current collection engine performance was still low.

[0012] Moreover, the current collection member which has a complicated configuration is not only needed, but with the current collection structure which carries out laser

welding of the current collection member in which two or more slits were cut like drawing 9 to the axis edge, since the welding operation to a current collection member was required, there was a problem inferior to productivity.

[0013] The object of this invention has internal resistance lower than before, and is offering the cylindrical nonaqueous electrolyte rechargeable battery which has the current collection structure which excelled [**] in productivity.

[0014]

[Means for Solving the Problem] In the cylindrical nonaqueous electrolyte rechargeable battery concerning this invention The rolling-up electrode object (4) which the separator (42) containing nonaqueous electrolyte was made to intervene between band-like positive electrodes (41) and negative electrodes (43), respectively, and rolled these round inside the cell can (1) at the curled form is contained. A positive electrode (41) and a negative electrode (43) apply an active material to the front face of a band-like axis, are constituted, and can take out the power which a rolling-up electrode object (4) generates from the electrode terminal area of a couple to the exterior, respectively. In one [at least] edge of the volume shaft orientations of this rolling-up electrode object (4) The axis non-coating section (40) by which an active material is not applied to the axis which constitutes a positive electrode (41) or a negative electrode (43) A projection, This lobe is divided into two or more ring-like fields (4a) (4b) (4c). Each ring-like field is governed by the non-coating axis bundle (49) with the current collection terminal (5) in 1 of the hoop direction, or two or more places. Each current collection terminal (5) consists of the rivet members (54) and washer members (53) which have been arranged on both sides of a non-coating axis bundle (49) at both sides, and the rivet member (54) has the plate-like head (51) and the shank (52). And a shank (52) penetrates a non-coating axis bundle (49), a lead (7), and a washer member (53), by closing the point of this shank (52), the non-coating axis bundle (49) and the lead (7) are compressed between the plate-like head (51) of a rivet member (54), and a washer member (53), and each lead (7) is connected with the electrode terminal area.

[0015] In the configuration of the cylindrical nonaqueous electrolyte rechargeable battery of above-mentioned this invention, each current collection terminal (5) has the simple structure which consists of a rivet member (54) and a washer member (53). Moreover, since each current collection terminal (5) is attached in each ****** axis bundle (49) of a rolling-up electrode object (4) by caulking immobilization, it does not need to perform welding etc. and that of an installation process is simple. Furthermore, while a non-coating axis bundle (49) is strongly compressed by the plate-like head (51) of a rivet member (54), and the washer member (53) from both sides and axis sides are

stuck by pressure strongly Since the shank (52) of a rivet member (54) has penetrated the non-coating axis bundle (49) and the lead (7), even if big pull strength acts on a current collection terminal (5), there is no possibility of separating from a non-coating axis bundle (49) and a lead (7). Thus, while the axis sides of a non-coating axis bundle (49) are stuck by pressure strongly mutually, since the non-coating axis bundle (49) and the lead (7) are strongly stuck by pressure with the inner surface of the plate-like head (51) of a rivet member (54), and a washer member (53), the electric resistance in the mutual contact surface becomes very small.

[0016] In the concrete configuration of this invention, said two or more current collection terminals are arranged in the location which carries out the abbreviation division-into-equal-parts rate of the die length when developing a curled form axis. According to this concrete configuration, with two or more current collection terminals, since current collection is carried out to homogeneity from a rolling-up electrode object, the high current collection engine performance is obtained.

[0017] Furthermore, in other concrete configurations, cylindrical or the conic crevice (55) reduced toward the method of the back is formed in the apical surface of the shank (52) of the rivet member (54) which constitutes each current collection terminal (5). Since the thickness of the shank (52) which surrounds said crevice (55) becomes thin according to this concrete configuration, in a caulking process, the big force is unnecessary.

[0018] In addition, as the current collection terminal by the side of a positive electrode (5), and construction material of a lead (7), aluminum, stainless steel, nickel, etc. can be used and copper, stainless steel, nickel, etc. can be used as the current collection terminal by the side of a negative electrode (5), and construction material of a lead (7). A kind of ingredient chosen from the group which consists of LiCoO2, LiNiO2, LiCo1-XNiXO2, LiMn(s) 2O4, and these conjugated compounds of a metallic oxide as positive active material can be used at least. As construction material of a negative-electrode active material, conductive polymers, such as carbon materials, such as a graphite and corks, a lithium metal, a lithium alloy, LiXFe 2O3, a metallic-oxide ingredient of LiXWO2 grade, and polyacethylene, are mentioned. As an electrolyte, LiPF6, LiClO4, and the LiCF3SO3 grade containing metal ions, such as a lithium ion, are mentioned. Moreover, it is independent to an electrolytic organic solvent, or ethylene carbonate, diethyl carbonate, dimethoxymethane, a sulfolane, etc. can be mixed and used for it. As the electrolytic solution, the solution which dissolved said electrolyte in these solvents at a rate of 0.7 - 1.5M (mol/l) extent is mentioned.

[0019]

[Effect of the Invention] Since the activity which attaches a current collection terminal (5) in the axis non-coating section (40) of a rolling-up electrode object (4) is simple according to the cylindrical nonaqueous electrolyte rechargeable battery concerning this invention, productivity higher than before is realized. Moreover, since the electric resistance between a rolling-up electrode object (4) and an electrode terminal area can be suppressed small, current collection effectiveness is improved and output density higher than before is obtained.

[0020]

[Embodiment of the Invention] Hereafter, this invention is concretely explained along with a drawing about the gestalt carried out to the cylindrical rechargeable lithium-ion battery.

[0021] As shown in drawing 4 and drawing 1 , the cylindrical rechargeable lithium-ion battery of example this example holds a rolling-up electrode object (4) in the interior of the cell can (1) of the shape of a cylinder which carries out welding immobilization of a lid (12) and (12), and becomes the both ends of a barrel (11), and is constituted. A style (9) and (9) are attached. both lids (12) and (12) -- the electrode edge of a positive/negative couple -- a cordless handset -- the power which the two poles of a rolling-up electrode object (4), a two-electrodes terminal device (9), and (9) are mutually connected according to the current collection structure mentioned later, respectively, and a rolling-up electrode object (4) generates -- the electrode edge of a couple -- a cordless handset -- it is possible to take out from a style (9) and (9) outside. Moreover, the gas exhaust valve (13) of a pressure closing motion type is attached in each lid (12).

[0022] As shown in drawing 7 , a rolling-up electrode object (4) makes a band-like separator (42) intervene between band-like positive electrodes (41) and negative electrodes (43), respectively, winds these around a curled form and is constituted. A positive electrode (41) applies the positive active material (44) which consists of a lithium multiple oxide to both sides of the band-like axis (45) which consists of aluminium foil, and is constituted, and a negative electrode (43) applies the negative-electrode active material (46) containing a carbon material to both sides of the band-like axis (47) which consists of copper foil, and is constituted. Impregnation of the nonaqueous electrolyte is carried out to the separator (42). Moreover, the axis non-coating section (40) to which positive active material (44) is not applied is formed in one edge of a positive electrode (41), and the axis non-coating section (40) to which a negative-electrode active material (46) is not applied is formed in the other-end section of a negative electrode (43).

[0023] In production of a rolling-up electrode object (4), respectively a positive electrode

(41) and a negative electrode (43) are shifted crosswise, are piled up on a separator (42), and are rolled round by the curled form. By this, at one edge, among the both ends of the volume shaft orientations of a rolling-up electrode object (4) While the edge (48) of the axis non-coating section (40) of a positive electrode (41) projects to the method of outside [edge / of a separator (42)], in the other-end section, the edge (48) of the axis non-coating section (40) of a negative electrode (43) projects to the method of outside [edge / of a separator (42)].

[0024] And two or more current collection terminals (5) are attached in the both ends by the side of the positive electrode of a rolling-up electrode object (4), and a negative electrode, respectively. A current collection terminal (5) consists of a rivet member (54) and a washer member (53), as shown in drawing 3 (a). The rivet member (54) protrudes the plate-like head (51) on the end face section of a shank (52), and the cylinder-like crevice (55) is formed in the apical surface of a shank (52). It is also possible to change to a cylinder-like crevice (55) and to form the conic crevice (55) reduced toward the method of the back as shown in this drawing (b). In addition, the current collection terminal for positive electrodes (5) is a product made from aluminum, and the current collection terminal for negative electrodes (5) is copper.

[0025] As shown in drawing 1 , each axis non-coating section (40) of a rolling-up electrode object (4) It is divided into the ring-like field (4a) (4b) (4c) to which the die length when developing an axis becomes equal and whose number is three, a current collection terminal (5) is attached in each ring-like field so that a ring-like field may be put from both sides, and six non-coating axis bundles (49) are formed in it of this. and the lead (7) whose polarity the end face section of a band-like lead (7) is connected with each current collection terminal (5), and is the six same sheets -- one electrode edge -- a cordless handset -- it connects with the flange (92) of a style (9).

[0026] Drawing 2 (a), (b), and (c) express the process which attaches a current collection terminal (5) in the axis non-coating section (40) of a rolling-up electrode object (4). The shank (52) of a rivet member (54) is made to penetrate first, to the breakthrough (56) of the lead (7) axis non-coating section (40) and a washer member (53), as shown in this drawing (b) where a lead (7) and the axis non-coating section (40) are inserted between a rivet member (54) and a washer member (53) as shown in this drawing (a). In addition, in a lead (7) and the axis non-coating section (40), the hole for making a shank (52) penetrate is established beforehand.

[0027] Then, like drawing 2 (c), where a lead (7) and the axis non-coating section (40) are strongly compressed by the plate-like head (51) and the washer member (53), the point (52a) of a shank (52) is closed. Consequently, a non-coating axis bundle (49) is

formed, a non-coating axis bundle (49) is strongly compressed by the plate-like head (51) of a rivet member (54), and the washer member (53) from both sides, and axis sides stick it by pressure strongly by them. Here, since the shank (52) of a rivet member (54) has penetrated the non-coating axis bundle (49) and the lead (7), even if big pull strength acts on a current collection terminal (5), a possibility of separating from a non-coating axis bundle (49) and a lead (7) does not have a rivet member (54).

[0028] it is shown in drawing 1 -- as -- an electrode edge -- a cordless handset -- a style (9) is equipped with the electrode terminal (91) attached by penetrating the lid (12) of a cell can (1), and the flange (92) is formed in the end face section of this electrode terminal (91). The breakthrough of a lid (12) is equipped with an insulating member (93), and a lid (12), the electric insulation between electrode terminals (91), and seal nature are maintained. While a washer (94) is inserted in from the outside of a lid (12), the 1st nut (95) and the 2nd nut (96) are screwing in an electrode terminal (91). And seal nature is raised by binding the 1st nut (95) tight and compressing an insulating member (93) with the flange (92) and washer (94) of an electrode terminal (91). The point of the lead (7) extended from each current collection terminal (5) is welded to the rear face of the flange (92) of an electrode terminal (91). In addition, the lead by the side of a positive electrode (7) is a product made from aluminum, and the lead by the side of a negative electrode (7) is copper.

[0029] In the above-mentioned cylindrical rechargeable lithium-ion battery, since a current collection terminal (5) is attached in each ****** axis bundle (49) of a rolling-up electrode object (4) by caulking immobilization, it does not need to perform welding etc. and that of an installation process is simple. Moreover, a non-coating axis bundle (49) is strongly compressed by the plate-like head (51) of a rivet member (54), and the washer member (53) from both sides, and axis sides stick it by pressure strongly. Here, since the shank (52) of a rivet member (54) has penetrated the non-coating axis bundle (49) and the lead (7), even if big pull strength acts on a current collection terminal (5), a possibility of separating from a non-coating axis bundle (49) and a lead (7) does not have a rivet member (54). Thus, while the axis sides of a non-coating axis bundle (49) are stuck by pressure strongly mutually, since a non-coating axis bundle (49) and a lead (7) are strongly stuck by pressure with the inner surface of the plate-like head (51) of a rivet member (54), and a washer member (53), the electric resistance in the mutual contact surface becomes very small. Moreover, since the thickness of the part which surrounds the crevice (55) of a shank (52) becomes thin, in a caulking process, the big force is unnecessary. Furthermore, with two or more current collection terminals (5), since current collection is carried out to homogeneity from a rolling-up electrode object

(4), the high current collection engine performance is obtained.

[0030] Next, the manufacture approach of the cylindrical rechargeable lithium-ion battery of this example is explained.

[0031] the carbon as LiNi0.7Co 0.3O2 and the electric conduction agent as [production of positive electrode] positive active material -- the rate of the weight ratio 90:5 -- mixing -- a positive electrode -- a mixture is obtained. Next, the polyvinylidene fluoride which is a binder is dissolved in a N-methyl-2-pyrrolidone (NMP), and a NMP solution is prepared. and a positive electrode -- the weight ratio of a mixture and polyvinylidene fluoride is set to 95:5 -- as -- a positive electrode -- a mixture and a NMP solution are kneaded and a slurry is prepared. This slurry is applied to both sides of the aluminium foil as a positive-electrode axis whose thickness is 20 micrometers with a doctor blade method, the vacuum drying of 2 hours is performed at 150 degrees C, and a positive electrode is obtained. In addition, the width of face from the axis edge forms in a positive-electrode axis the non-coating section which is 20mm.

[0032] The polyvinylidene fluoride which is [production of negative electrode] binder is dissolved in NMP, and a NMP solution is prepared. And graphite powder, the end of a coke breeze, and a NMP solution are kneaded so that the weight ratio of graphite powder, the end of a coke breeze, and polyvinylidene fluoride may be set to 72:18:10, and a slurry is prepared. This slurry is applied to both sides of the copper foil as a negative-electrode axis whose thickness is 10 micrometers with a doctor blade method, the vacuum drying of 2 hours is performed at 150 degrees C, and a negative electrode is obtained. In addition, the width of face from the axis edge forms in a negative-electrode axis the non-coating section which is 20mm.

[0033] LiPF6 is dissolved in the solvent which mixed [adjustment of the electrolytic solution] ethylene carbonate, and diethyl carbonate by the volume ratio 1:1 at a rate of 1 mol/L, and the electrolytic solution is adjusted.

[0034] The rolling-up electrode object (4) shown in drawing 7 is produced using the positive electrode and negative electrode which were obtained according to the process beyond [assembly of a cell], and the separator which consists of fine porous membrane made from polyethylene of ionic permeability. and the die length when developing the axis of each forward negative electrode, as shown in drawing 1 -- abbreviation -- it becomes equal -- the axis non-coating section (40) is divided into three ring-like fields (4a) (4b) (4c) like. Next, as shown in drawing 2 (a) and (b), a breakthrough is established in each lead (7) and the axis non-coating section (40), the shank (52) of a pin member (54) is inserted in this breakthrough, and a washer member (53) is inserted in at the head of this shank (52). And as shown in this drawing (c), where a non-coating axis

bundle (49) and a lead (7) are compressed, the point (52a) of a shank (52) is closed. Then, a rolling-up electrode object (4) is held in a barrel (11). on the other hand -- each lid (12) -- an electrode edge -- a cordless handset -- while attaching a style (9), the point of the lead (7) extended from each current collection terminal by the side of a positive electrode and a negative electrode (5) is welded to the rear face of the flange (92) of the electrode terminal by the side of a positive electrode and a negative electrode (91), respectively. Finally, welding immobilization of the lid (12) is carried out at each opening of a barrel (11), and the cylindrical rechargeable lithium-ion battery of this example is assembled.

[0035] The conventional cylindrical rechargeable lithium-ion battery (conventional cell) which has the current collection device shown in the cylindrical rechargeable lithium-ion battery (example cell) shown in measurement drawing 1 of internal resistance and drawing 5 was produced, and the alternating current impedance was measured as internal resistance of each cell.

[0036] With the making process of [production of conventional cell] positive electrode, and a negative electrode, the positive electrode and the negative electrode were produced like the above-mentioned example except having applied the slurry to the axis completely, without preparing the axis non-coating section. In the assembly of a cell, as shown in drawing 6 R> 6, while welding 15 electrode tabs made from aluminum to the front face of the aluminium foil which constitutes the positive electrode at intervals of 20cm, 15 copper electrode tabs were welded to the front face of the copper foil which constitutes the negative electrode at intervals of 20cm. And the separator which consists of fine porous membrane made from polyethylene of ionic permeability was inserted between the positive electrode and the negative electrode, and winding and a rolling-up electrode object (2) were produced for these to the curled form. In addition, thickness of the electrode tab of a positive electrode and a negative electrode was set to 0.1mm. and it is shown in drawing 5 -- as -- the electrode tab (3) of each electrode -- an electrode edge -- a cordless handset -- it welded to the flange (92) of a style (9), and the cell was assembled conventionally. In addition, an example cell and conventionally, the active material coverage of each electrode of a cell considered as tales doses, and the size of each cell made it the same.

[0037] Before holding the rolling-up electrode object of [measuring method] each cell in a barrel, the alternating current impedance in 1kHz was measured. The positive-electrode and negative-electrode side performed measurement between the axis non-coating sections and the electrode terminals which are located in the outermost periphery of a rolling-up electrode object.

[0038] The result shown in the following table 1 was obtained about the cell a [measurement result] example cell and conventionally.

[0039]

[A table 1]

Battery	Impedance of the side of a negative electrode	Impedance of the side of a positive electrode
Example battery	3.8m Ω	8.0m Ω
Conventional battery	10.8m Ω	25.5m Ω

[0040] Also in any by the side of a positive electrode and a negative electrode, the alternating current impedance of an example cell is conventionally smaller than the alternating current impedance of a cell, and according to the cylindrical rechargeable lithium-ion battery of this invention, it can be said from this that output density higher than the conventional cell can be obtained so that clearly from the result shown in a table 1.

[Brief Description of the Drawings]

[Drawing 1] It is drawing showing the cross-section configuration and flat-surface configuration of current collection structure which are adopted as the cylindrical rechargeable lithium-ion battery concerning this invention.

[Drawing 2] It is drawing which expresses the process which carries out caulking immobilization of the current collection terminal to a lead and a non-coating axis bundle.

[Drawing 3] It is an amplification perspective view showing two examples of a configuration of a current collection terminal.

[Drawing 4] It is the perspective view showing the appearance of a cylindrical rechargeable lithium-ion battery.

[Drawing 5] It is a sectional view showing the current collection structure adopted as the conventional cylindrical rechargeable lithium-ion battery.

[Drawing 6] some rolling-up electrode objects with which this rechargeable battery is equipped -- it is an expansion perspective view.

[Drawing 7] it had other conventional current collection structures -- rolling round -- some electrode objects -- it is an expansion perspective view.

[Drawing 8] It is a perspective view showing the conventional current collection structure of further others.

[Drawing 9] It is a perspective view showing the conventional current collection structure of further others.

[Description of Notations]

(1) Cell can
(11) Barrel
(12) Lid
(4) Rolling-up electrode object
(49) Non-coating axis bundle
(5) Current collection terminal
(53) Washer member
(54) Rivet member
(51) Plate-like head
(52) Shank
(7) Lead
(9) Electrode terminal device

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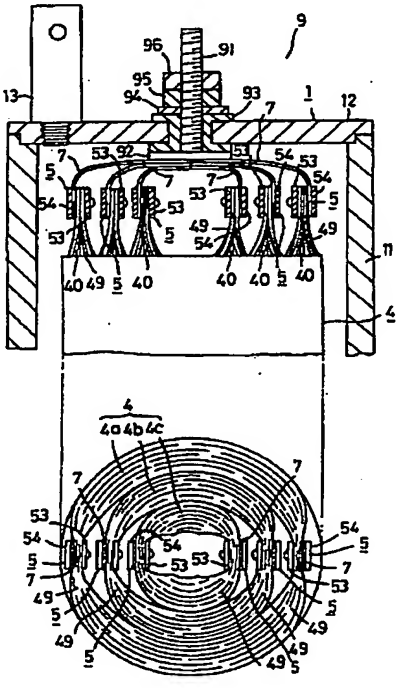
最終頁に続く

(54)【発明の名称】　円筒型非水電解液二次電池

(57)【要約】
【課題】　従来よりも内部抵抗が低く、然も生産性に優れた集電構造を有する円筒型非水電解液二次電池を提供する。
【解決手段】　本発明に係る円筒型非水電解液二次電池においては、巻き取り電極体４の軸方向の端部に、正極或いは負極を構成する芯体に活物質の塗布されていない芯体非塗工部が突出し、該突出部には、複数の集電端子５が取り付けられている。各集電端子５はリベット部材54とワッシャ部材53から構成され、リベット部材54は平板状頭部と軸部を有している。軸部は非塗工芯体束49、リード７及びワッシャ部材53を貫通し、該軸部の先端部をかしめることによって平板状頭部とワッシャ部材53との間に非塗工芯体束49及びリード７を狭圧しており、各リード７は電極端子部９と連結されている。



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【特許請求の範囲】

【請求項１】　円筒状の電池缶（１）の内部に、それぞれ帯状の正極(41)と負極(43)の間に非水電解液を含むセパレータ(42)を介在させてこれらを渦巻き状に巻き取った巻き取り電極体（４）が収納され、正極(41)及び負極(43)はそれぞれ、帯状芯体の表面に活物質を塗布して構成され、巻き取り電極体（４）が発生する電力を一対の電極端子部から外部へ取り出すことが出来る円筒型非水電解液二次電池において、巻き取り電極体（４）の巻き軸方向の少なくとも一方の端部には、正極(41)或いは負極(43)を構成する芯体に活物質の塗布されていない芯体非塗工部が突出し、該突出部は複数のリング状領域(4a)(4b)(4c)に分けられて、各リング状領域はその周方向の１或いは複数箇所にて集電端子（５）により非塗工芯体束(49)に束ねられており、各集電端子（５）は非塗工芯体束(49)を挟んで両側に配置されたリベット部材(54)とワッシャ部材(53)から構成され、リベット部材(54)は平板状頭部(51)と軸部(52)を有しており、軸部(52)は非塗工芯体束(49)とリード（７）及びワッシャ部材(53)を貫通し、該軸部(52)の先端部をかしめることによってリベット部材(54)の平板状頭部(51)とワッシャ部材(53)との間に非塗工芯体束(49)及びリード（７）を狭圧しており、各リード（７）が電極端子部と連結されていることを特徴とする円筒型非水電解液二次電池。

【請求項２】　複数の集電端子（５）は、渦巻き状の芯体を展開したときの長さを略等分割する位置に配置されている請求項１に記載の円筒型非水電解液二次電池。

【請求項３】　各集電端子（５）を構成するリベット部材(54)の軸部(52)の先端面には、円柱状又は奥方に向かって縮小する円錐状の凹部(55)が形成されている請求項１又は請求項２に記載の円筒型非水電解液二次電池。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、電池缶の内部に二次電池要素となる巻き取り電極体が収容されて、電池缶に設けた一対の電極端子部から巻き取り電極体の発生電力を取り出すことが出来る円筒型非水電解液二次電池に関するものである。

【０００２】

【従来の技術】近年、携帯型電子機器、電気自動車等の電源として、エネルギー密度の高いリチウムイオン二次電池が注目されている。例えば電気自動車に用いられる比較的大きな容量の円筒型リチウムイオン二次電池は、図４及び図５に示す様に、筒体(11)の両端部に蓋体(12)(12)を溶接固定してなる円筒状の電池缶（１）の内部に、図６に示す巻き取り電極体（２）を収容して構成されている。両蓋体(12)(12)には、正負一対の電極端子機構（９）（９）が取り付けられており、巻き取り電極体（２）の両極と両電極端子機構（９）（９）とが、それぞれ複数本の電極タブ（３）により互いに接続されて、巻き取り電極体（２）

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が発生する電力を一対の電極端子機構（９）（９）から外部に取り出すことが可能となっている。又、各蓋体(12)には圧力開閉式のガス排出弁(13)が取り付けられている。

【０００３】図６に示す巻き取り電極体（２）は、それぞれ帯状の正極(21)と負極(23)の間に帯状のセパレータ(22)を介在させて、これらを渦巻き状に巻回して構成されている。正極(21)は、アルミニウム箔からなる帯状芯体の両面にリチウム複合酸化物からなる正極活物質(24)を塗布して構成され、負極(23)は、銅箔からなる帯状芯体の両面に炭素材料を含む負極活物質(25)を塗布して構成されている。セパレータ(22)には、非水電解液が含浸されている。正極(21)及び負極(23)には夫々、複数本の電極タブ（３）の基端部がスポット溶接等によって接合され、先端部は巻き取り電極体（２）から突出している。尚、正極(21)に接合された電極タブ（３）はアルミニウム箔から形成され、負極(23)に接合された電極タブ（３）は銅箔から形成されている。

【０００４】そして、図５に示す如く、極性が同じ複数本の電極タブ（３）の先端部(31)が１つの電極端子機構（９）に接続されている。尚、図５においては、便宜上、一部の電極タブの先端部が電極端子機構（９）に接続されている状態のみを示し、他の電極タブについては、先端部が電極端子機構（９）に接続されている状態の図示を省略している。

【０００５】電極端子機構（９）は、電池缶（１）の蓋体(12)を貫通して取り付けられた電極端子(91)を具え、該電極端子(91)の基端部には鍔部(92)が形成されている。蓋体(12)の貫通孔には絶縁部材(93)が装着され、蓋体(12)と電極端子(91)の間の電気的絶縁性とシール性が保たれている。電極端子(91)には、蓋体(12)の外側からワッシャ(94)が嵌められると共に、第１ナット(95)及び第２ナット(96)が螺合している。そして、第１ナット(95)を締め付けて、電極端子(91)の鍔部(92)とワッシャ(94)によって絶縁部材(93)を挟圧することにより、シール性を高めている。前記複数本の電極タブ（３）の先端部(31)は、電極端子(91)の鍔部(92)に、スポット溶接或いは超音波溶接によって固定されている。

【０００６】ところで、リチウムイオン二次電池においては、電池の大型化に伴って、正極及び負極の長さが大きくなるため、上述の如き電極タブによる集電構造では集電性が低く、内部抵抗にばらつきが発生したり、放電容量が低下するなどの問題が生じる。

【０００７】そこで、正極及び負極の全長に亘って均一な集電性を得るべく、図７に示す如き集電構造が提案されている。該集電構造において、巻き取り電極体（４）は同様に、芯体(45)の表面に正極活物質(44)を塗布してなる正極(41)と、芯体(47)の表面に負極活物質(46)を塗布してなる負極(43)と、非水電解液が含浸されたセパレータ(42)とから構成されるが、正極(41)及び負極(43)はそれぞれセパレータ(42)上に幅方向へずらして重ね合わさ

れ、渦巻き状に巻き取られている。これによって、巻き取り電極体(４)の巻き軸方向の両端部の内、一方の端部では、セパレータ(42)の端縁よりも外方へ正極(41)の芯体(45)の端縁(48)が突出すると共に、他方の端部では、セパレータ(42)の端縁よりも外方へ負極(43)の芯体(47)の端縁(48)が突出している。そして、巻き取り電極体(４)の両端部において、それぞれ円板状の集電板(32)が正負両極の芯体の端縁(48)(48)と溶接され、該集電板(32)がリード部材(33)を介して前記電極端子機構(９)に接続される。

【０００８】しかしながら、図７に示す集電構造を有する非水電解液二次電池においては、巻き取り電極体(４)の正極(41)及び負極(43)を構成する芯体(45)(47)の端縁(48)(48)の面積が小さいため、芯体端縁と集電板(32)の間の接触面積が小さく、これによって電池の内部抵抗が大きくなる問題があった。又、高出力を得るためには、出来るだけ内部抵抗を低減させることが必要であり、更に、製造コスト削減のためには、生産性に優れた集電構造が必要となる。

【０００９】そこで、図８に示す様に、平板状本体(63)に複数の折曲部(64)を形成した集電板(62)を用い、該集電板(62)を巻き取り電極体(４)の芯体端縁(48)に押し付けた状態で、該折曲部(64)を芯体端縁(48)に抵抗溶接する集電構造が提案されている(例えば特開平１１－３１４９７号参照)。

【００１０】又、円板状の集電板に代えて、図９に示す如く複数のスリット(66)が凹設された集電部材(65)を巻き取り電極体(４)の端部に設置し、該集電部材(65)のスリット(66)へ芯体端縁(48)を嵌入せしめた状態で、集電部材(65)の表面にレーザビームを照射して、レーザ溶接を施す集電構造が提案されている(例えば特開平１０－２６１４４１号参照)。

【００１１】

【発明が解決しようとする課題】ところが、図８の如く折曲部を形成した集電板を抵抗溶接する集電構造においては、リチウムイオン二次電池の如く芯体の厚さが極めて小さい場合、溶接が困難であるばかりでなく、溶接部における電気抵抗が大きく、依然として集電性能が低い問題があった。

【００１２】又、図９の如く複数のスリットが凹設された集電部材を芯体端縁にレーザ溶接する集電構造では、複雑な形状を有する集電部材が必要となるばかりでなく、集電部材に対する溶接作業が必要であるために生産性に劣る問題があった。

【００１３】本発明の目的は、従来よりも内部抵抗が低く、然も生産性に優れた集電構造を有する円筒型非水電解液二次電池を提供することである。

【００１４】

【課題を解決する為の手段】本発明に係る円筒型非水電解液二次電池においては、電池缶(１)の内部に、それぞ

れ帯状の正極(41)と負極(43)の間に非水電解液を含むセパレータ(42)を介在させてこれらを渦巻き状に巻き取った巻き取り電極体(４)が収納され、正極(41)及び負極(43)はそれぞれ、帯状芯体の表面に活物質を塗布して構成され、巻き取り電極体(４)が発生する電力を一対の電極端子部から外部へ取り出すことが出来る。該巻き取り電極体(４)の巻き軸方向の少なくとも一方の端部には、正極(41)或いは負極(43)を構成する芯体に活物質の塗布されていない芯体非塗工部(40)が突出し、該突出部は複数のリング状領域(4a)(4b)(4c)に分けられて、各リング状領域はその周方向の１或いは複数箇所にて集電端子(５)により非塗工芯体束(49)に束ねられており、各集電端子(５)は非塗工芯体束(49)を挟んで両側に配置されたリベット部材(54)とワッシャ部材(53)から構成され、リベット部材(54)は平板状頭部(51)と軸部(52)を有している。そして、軸部(52)は非塗工芯体束(49)とリード(７)及びワッシャ部材(53)を貫通し、該軸部(52)の先端部をかしめることによってリベット部材(54)の平板状頭部(51)とワッシャ部材(53)との間に非塗工芯体束(49)及びリード(７)を狭圧しており、各リード(７)が電極端子部と連結されている。

【００１５】上記本発明の円筒型非水電解液二次電池の構成において、各集電端子(５)は、リベット部材(54)及びワッシャ部材(53)から構成される単純な構造を有している。又、各集電端子(５)は、巻き取り電極体(４)の各非塗工芯体束(49)にかしめ固定によって取り付けられるので、溶接等を施す必要がなく、取り付け工程は簡易である。更に、非塗工芯体束(49)は、リベット部材(54)の平板状頭部(51)とワッシャ部材(53)により、両側から強く狭圧されて、芯体面どうしが強く圧着すると共に、リベット部材(54)の軸部(52)が非塗工芯体束(49)及びリード(７)を貫通しているので、集電端子(５)に大きな引張り力が作用したとしても、非塗工芯体束(49)及びリード(７)から外れる虞れはない。この様にして、非塗工芯体束(49)の芯体面どうしが互いに強く圧着すると共に、非塗工芯体束(49)及びリード(７)は、リベット部材(54)の平板状頭部(51)及びワッシャ部材(53)の内面と強く圧着しているので、互いの接触面における電気抵抗は極めて小さくなる。

【００１６】本発明の具体的構成において、前記複数の集電端子は、渦巻き状の芯体を展開したときの長さを略等分割する位置に配置されている。該具体的構成によれば、複数の集電端子によって、巻き取り電極体から均一に集電が行なわれるので、高い集電性能が得られる。

【００１７】更に他の具体的構成において、各集電端子(５)を構成するリベット部材(54)の軸部(52)の先端面には、円柱状又は奥方に向かって縮小する円錐状の凹部(55)が形成されている。該具体的構成によれば、前記凹部(55)を包囲する軸部(52)の肉厚は薄くなるので、かしめ工程において大きな力は不要である。

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【００１８】尚、正極側の集電端子（５）及びリード（７）の材質としては、アルミニウム、ステンレス鋼、ニッケル等を用いることが出来、負極側の集電端子（５）及びリード（７）の材質としては、銅、ステンレス鋼、ニッケル等を用いることが出来る。正極活物質としては、金属酸化物の$LiCoO_2$、$LiNiO_2$、$LiCo_{1-x}Ni_xO_2$、$LiMn_2O_4$及びこれらの複合化合物からなる群から選択された少なくとも一種の材料を用いることが出来る。負極活物質の材質としては、黒鉛、コークスなどの炭素材料、リチウム金属、リチウム合金、$Li_xFe_2O_3$、Li_xWO_2等の金属酸化物材料、ポリアセチレン等の導電性高分子材料が挙げられる。電解質としては、リチウムイオンなどの金属イオンを含む$LiPF_6$、$LiClO_4$、$LiCF_3SO_3$等が挙げられる。また、電解質の有機溶媒には、エチレンカーボネート、ジエチルカーボネート、ジメトキシメタン、スルホラン等を単独で或いは混合して用いることが出来る。電解液としては、これら溶媒に前記電解質を０．７～１．５Ｍ（ｍｏｌ／ｌ）程度の割合で溶解した溶液が挙げられる。

【００１９】

【発明の効果】本発明に係る円筒型非水電解液二次電池によれば、巻き取り電極体（４）の芯体非塗工部(40)に集電端子（５）を取り付ける作業は簡易であるので、従来よりも高い生産性が実現される。又、巻き取り電極体（４）と電極端子部の間の電気抵抗を小さく抑えることが出来るので、集電効率が改善されて、従来よりも高い出力密度が得られる。

【００２０】

【発明の実施の形態】以下、本発明を円筒型リチウムイオン二次電池に実施した形態につき、図面に沿って具体的に説明する。

【００２１】実施例

本実施例の円筒型リチウムイオン二次電池は、図４及び図１に示す如く、筒体(11)の両端部に蓋体(12)(12)を溶接固定してなる円筒状の電池缶（１）の内部に、巻き取り電極体（４）を収容して構成されている。両蓋体(12)(12)には、正負一対の電極端子機構（９）（９）が取り付けられており、巻き取り電極体（４）の両極と両電極端子機構（９）（９）とが、それぞれ後述する集電構造により互いに接続されて、巻き取り電極体（４）が発生する電力を一対の電極端子機構（９）（９）から外部に取り出すことが可能となっている。又、各蓋体(12)には圧力開閉式のガス排出弁(13)が取り付けられている。

【００２２】巻き取り電極体（４）は、図７に示す様に、それぞれ帯状の正極(41)と負極(43)の間に帯状のセパレータ(42)を介在させて、これらを渦巻き状に巻回して構成されている。正極(41)は、アルミニウム箔からなる帯状芯体(45)の両面にリチウム複合酸化物からなる正極活物質(44)を塗布して構成され、負極(43)は、銅箔からなる帯状芯体(47)の両面に炭素材料を含む負極活物質(46)を塗布して構成されている。セパレータ(42)には、非水電解液が含浸されている。又、正極(41)の一方の端部には、正極活物質(44)の塗布されていない芯体非塗工部(40)が形成され、負極(43)の他方の端部には、負極活物質(46)の塗布されていない芯体非塗工部(40)が形成されている。

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【００２３】巻き取り電極体（４）の作製において、正極(41)及び負極(43)はそれぞれセパレータ(42)上に幅方向へずらして重ね合わされ、渦巻き状に巻き取られている。これによって、巻き取り電極体（４）の巻き軸方向の両端部の内、一方の端部では、セパレータ(42)の端縁よりも外方へ正極(41)の芯体非塗工部(40)の端縁(48)が突出すると共に、他方の端部では、セパレータ(42)の端縁よりも外方へ負極(43)の芯体非塗工部(40)の端縁(48)が突出している。

【００２４】そして、巻き取り電極体（４）の正極側及び負極側の両端部にはそれぞれ、複数の集電端子（５）が取り付けられる。集電端子（５）は、図３（ａ）に示す如くリベット部材(54)及びワッシャ部材(53)から構成される。リベット部材(54)は、軸部(52)の基端部に平板状頭部(51)を突設しており、軸部(52)の先端面には円柱状の凹部(55)が形成されている。円柱状の凹部(55)に替えて、同図（ｂ）の如く、奥方に向かって縮小する円錐状の凹部(55)を形成することも可能である。尚、正極用の集電端子（５）はアルミニウム製であり、負極用の集電端子（５）は銅製である。

【００２５】図１に示す如く、巻き取り電極体（４）の各芯体非塗工部(40)は、芯体を展開したときの長さが等しくなる３つのリング状領域(4a)(4b)(4c)に分けられて、各リング状領域には、リング状領域を両側から挟み込むように集電端子（５）が取り付けられ、これによって６つの非塗工芯体束(49)が形成されている。そして、各集電端子（５）には帯状のリード（７）の基端部が連結されており、極性が同じ６枚のリード（７）が一方の電極端子機構（９）の鍔部(92)に連結されている。

【００２６】図２（ａ）（ｂ）（ｃ）は、巻き取り電極体（４）の芯体非塗工部(40)に集電端子（５）を取り付ける工程を表わしている。先ず同図（ａ）の如く、リベット部材(54)とワッシャ部材(53)の間にリード（７）及び芯体非塗工部(40)を挟んだ状態で、同図（ｂ）の如く、リベット部材(54)の軸部(52)を、リード（７）、芯体非塗工部(40)及びワッシャ部材(53)の貫通孔(56)へ貫通せしめる。尚、予めリード（７）及び芯体非塗工部(40)には、軸部(52)を貫通せしめるための孔を開設しておく。

【００２７】その後、図２（ｃ）の如く平板状頭部(51)とワッシャ部材(53)によってリード（７）及び芯体非塗工部(40)を強く狭圧した状態で、軸部(52)の先端部(52a)をかしめる。この結果、非塗工芯体束(49)が形成され、リベット部材(54)の平板状頭部(51)とワッシャ部材(53)に

よって、非塗工芯体束(49)は両側から強く狭圧され、芯体面どうしが強く圧着する。ここで、リベット部材(54)の軸部(52)が非塗工芯体束(49)及びリード(7)を貫通しているので、集電端子(5)に大きな引張り力が作用したとしても、リベット部材(54)が非塗工芯体束(49)及びリード(7)から外れる虞れはない。

【００２８】図１に示す如く電極端子機構(9)は、電池缶(1)の蓋体(12)を貫通して取り付けられた電極端子(91)を具え、該電極端子(91)の基端部には鍔部(92)が形成されている。蓋体(12)の貫通孔には絶縁部材(93)が装着され、蓋体(12)と電極端子(91)の間の電気的絶縁性とシール性が保たれている。電極端子(91)には、蓋体(12)の外側からワッシャ(94)が嵌められると共に、第１ナット(95)及び第２ナット(96)が螺合している。そして、第１ナット(95)を締め付けて、電極端子(91)の鍔部(92)とワッシャ(94)によって絶縁部材(93)を挟圧することにより、シール性を高めている。各集電端子(5)から伸びるリード(7)の先端部は、電極端子(91)の鍔部(92)の裏面に溶接されている。尚、正極側のリード(7)はアルミニウム製であり、負極側のリード(7)は銅製である。

【００２９】上記円筒型リチウムイオン二次電池において、集電端子(5)は、巻き取り電極体(4)の各非塗工芯体束(49)にかしめ固定によって取り付けられるので、溶接等を施す必要がなく、取り付け工程は簡易である。又、非塗工芯体束(49)は、リベット部材(54)の平板状頭部(51)とワッシャ部材(53)により、両側から強く狭圧されて、芯体面どうしが強く圧着する。ここで、リベット部材(54)の軸部(52)が非塗工芯体束(49)及びリード(7)を貫通しているので、集電端子(5)に大きな引張り力が作用したとしても、リベット部材(54)が非塗工芯体束(49)及びリード(7)から外れる虞れはない。この様にして、非塗工芯体束(49)の芯体面どうしが互いに強く圧着すると共に、非塗工芯体束(49)及びリード(7)は、リベット部材(54)の平板状頭部(51)及びワッシャ部材(53)の内面と強く圧着するので、互いの接触面における電気抵抗は極めて小さくなる。又、軸部(52)の凹部(55)を包囲する部分の肉厚が薄くなるので、かしめ工程において大きな力は不要である。更に、複数の集電端子(5)によって、巻き取り電極体(4)から均一に集電が行なわれるので、高い集電性能が得られる。

【００３０】次に本実施例の円筒型リチウムイオン二次電池の製造方法について説明する。

【００３１】［正極の作製］正極活物質としての$LiNi_{0.7}Co_{0.3}O_2$と導電剤としての炭素を重量比９０：５の割合で混合し、正極合剤を得る。次に、結着剤であるポリフッ化ビニリデンをＮ－メチル－２－ピロリドン(ＮＭＰ)に溶解させて、ＮＭＰ溶液を調製する。そして、正極合剤とポリフッ化ビニリデンの重量比が９５：５になるように正極合剤とＮＭＰ溶液を混練して、スラリーを調製する。このスラリーを、厚さが２０μmの正極芯体としてのアルミニウム箔の両面にドクターブレード法により塗布し、１５０℃で２時間の真空乾燥を施して、正極を得る。尚、正極芯体には、芯体端縁からの幅が２０mmの非塗工部を形成する。

【００３２】［負極の作製］結着剤であるポリフッ化ビニリデンをＮＭＰに溶解させて、ＮＭＰ溶液を調製する。そして、黒鉛粉末とコークス粉末とポリフッ化ビニリデンの重量比が７２：１８：１０になる様に黒鉛粉末とコークス粉末とＮＭＰ溶液とを混練して、スラリーを調製する。このスラリーを、厚さが１０μmの負極芯体としての銅箔の両面にドクターブレード法により塗布し、１５０℃で２時間の真空乾燥を施して、負極を得る。尚、負極芯体には、芯体端縁からの幅が２０mmの非塗工部を形成する。

【００３３】［電解液の調整］エチレンカーボネートとジエチルカーボネートを体積比１：１で混合した溶媒に$LiPF_6$を１mol／Lの割合で溶解して電解液を調整する。

【００３４】［電池の組立］以上の工程によって得られた正極及び負極と、イオン透過性のポリエチレン製微多孔膜からなるセパレータとを用いて、図７に示す巻き取り電極体(4)を作製する。そして、図１に示す様に、正負極それぞれの芯体を展開したときの長さが略等しくなる様に、芯体非塗工部(40)を３つのリング状領域(4a)(4b)(4c)に分割する。次に、図２(a)(b)に示す様に、各リード(7)と芯体非塗工部(40)に貫通孔を開設して、該貫通孔にピン部材(54)の軸部(52)を挿入し、該軸部(52)の先端にワッシャ部材(53)を嵌める。そして、同図(c)に示す様に、非塗工芯体束(49)とリード(7)を狭圧した状態で、軸部(52)の先端部(52a)をかしめる。その後、巻き取り電極体(4)を筒体(11)内に収容する。一方、各蓋体(12)に電極端子機構(9)を取り付けると共に、正極側及び負極側の各集電端子(5)から伸びるリード(7)の先端部を、それぞれ正極側及び負極側の電極端子(91)の鍔部(92)の裏面に溶接する。最後に、筒体(11)の各開口部に蓋体(12)を溶接固定して、本実施例の円筒型リチウムイオン二次電池を組み立てる。

【００３５】内部抵抗の測定

図１に示す円筒型リチウムイオン二次電池(実施例電池)と図５に示す集電機構を有する従来の円筒型リチウムイオン二次電池(従来電池)を作製し、各電池の内部抵抗として交流インピーダンスを測定した。

【００３６】［従来電池の作製］正極及び負極の作製工程で、芯体非塗工部を設けることなく、芯体にスラリーを全面塗布したこと以外は上記実施例と同様にして、正極及び負極を作製した。電池の組み立てにおいては、図６に示す様に、正極を構成しているアルミニウム箔の表面に１５本のアルミニウム製電極タブを２０cm間隔で溶接すると共に、負極を構成している銅箔の表面に１５本の銅製電極タブを２０cm間隔で溶接した。そして、

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正極と負極の間にイオン透過性のポリエチレン製微多孔膜からなるセパレータを挟んで、これらを渦巻き状に巻回し、巻き取り電極体(2)を作製した。尚、正極及び負極の電極タブの厚さは０．１mmとした。そして、図５に示す如く、各電極の電極タブ(3)を電極端子機構(9)の鍔部(92)に溶接して、従来電池を組み立てた。尚、実施例電池と従来電池の各電極の活物質塗布量は同量とし、各電池のサイズは同じとした。

【００３７】［測定方法］各電池の巻き取り電極体を筒

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体に収容する前に、１ｋＨｚにおける交流インピーダンスを測定した。測定は、正極側、負極側ともに、巻き取り電極体の最外周部に位置する芯体非塗工部と電極端子との間で行なった。

【００３８】［測定結果］実施例電池及び従来電池について、下記表１に示す結果が得られた。

【００３９】

【表１】

電　池	負極側インピーダンス	正極側インピーダンス
実施例電池	３．８ｍΩ	８．０ｍΩ
従来電池	１０．８ｍΩ	２５．５ｍΩ

【００４０】表１に示す結果から明らかな様に、正極側、負極側の何れにおいても、実施例電池の交流インピーダンスは、従来電池の交流インピーダンスよりも小さくなっており、このことから、本発明の円筒型リチウムイオン二次電池によれば、従来の電池よりも高い出力密度を得ることが出来ると言える。

【図面の簡単な説明】

【図１】本発明に係る円筒型リチウムイオン二次電池に採用されている集電構造の断面構成及び平面構成を示す図である。

【図２】リード及び非塗工芯体束に集電端子をかしめ固定する工程を表わす図である。

【図３】集電端子の２つの構成例を表わす拡大斜視図である。

【図４】円筒型リチウムイオン二次電池の外観を示す斜視図である。

【図５】従来の円筒型リチウムイオン二次電池に採用されている集電構造を表わす断面図である。

【図６】該二次電池に装備されている巻き取り電極体の一部展開斜視図である。

【図７】従来の他の集電構造を具えた巻き取り電極体の一部展開斜視図である。

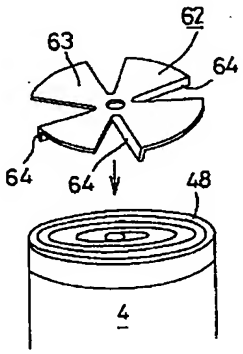
【図８】従来の更に他の集電構造を表わす斜視図である。

【図９】従来の更に他の集電構造を表わす斜視図である。

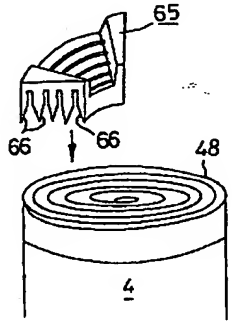
【符号の説明】

(1)　電池缶
(11)　筒体
(12)　蓋体
(4)　巻き取り電極体
(49)　非塗工芯体束
(5)　集電端子
(53)　ワッシャ部材
(54)　リベット部材
(51)　平板状頭部
(52)　軸部
(7)　リード
(9)　電極端子機構

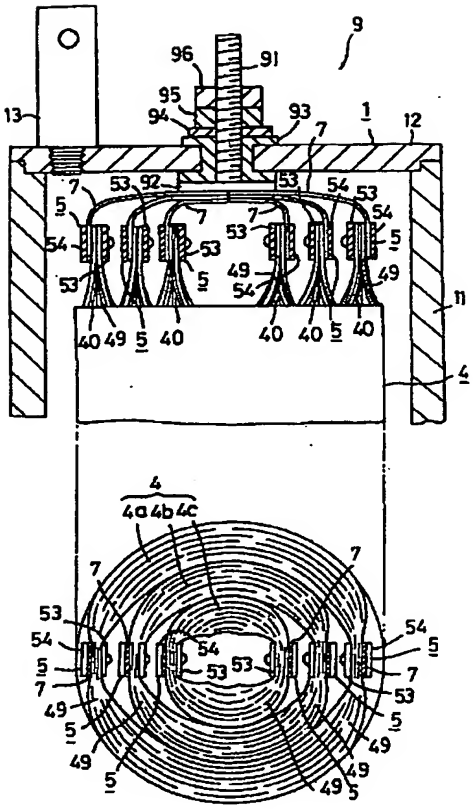
【図８】



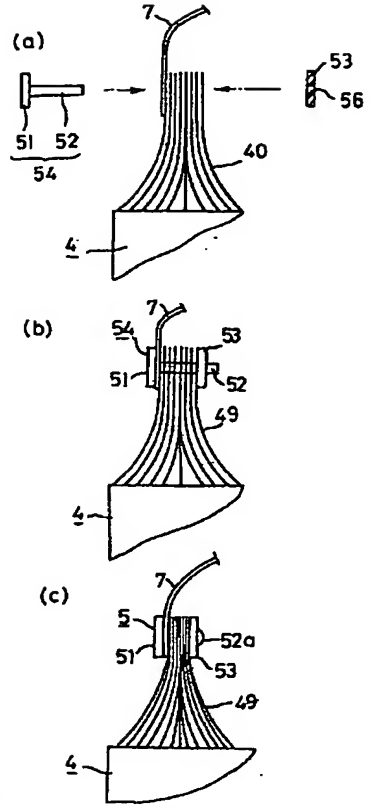
【図９】



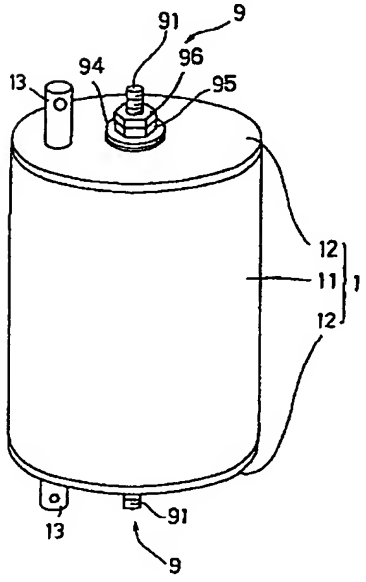
【図１】



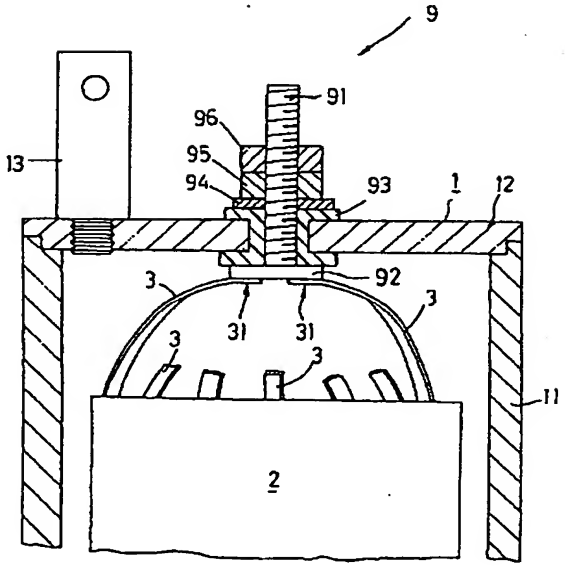
【図２】



【図４】



【図５】



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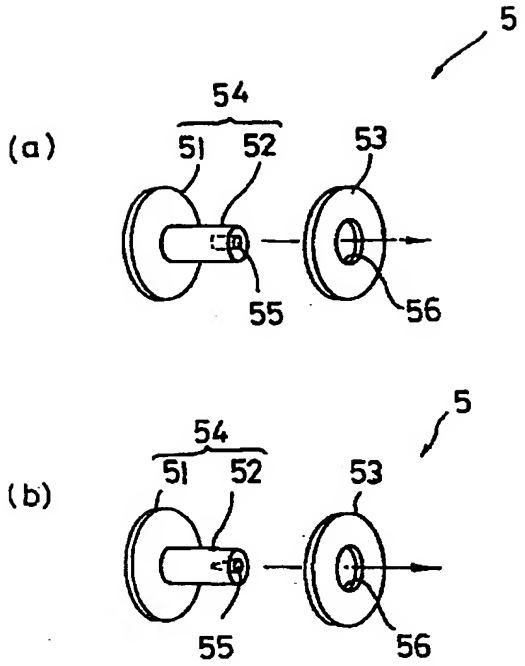

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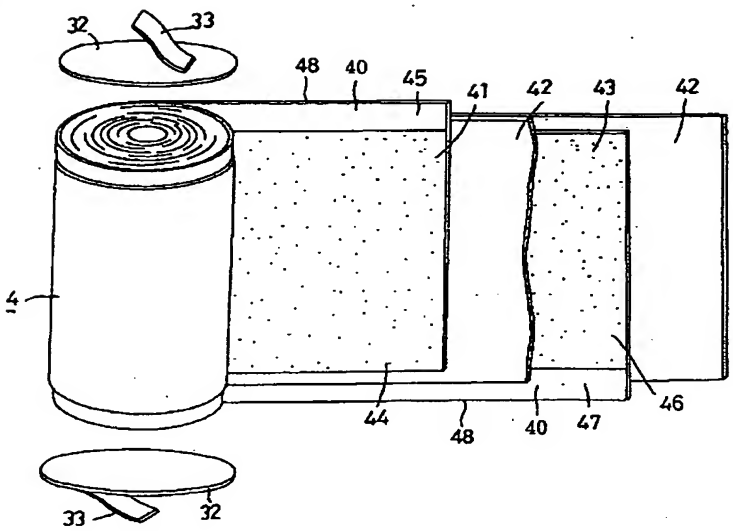

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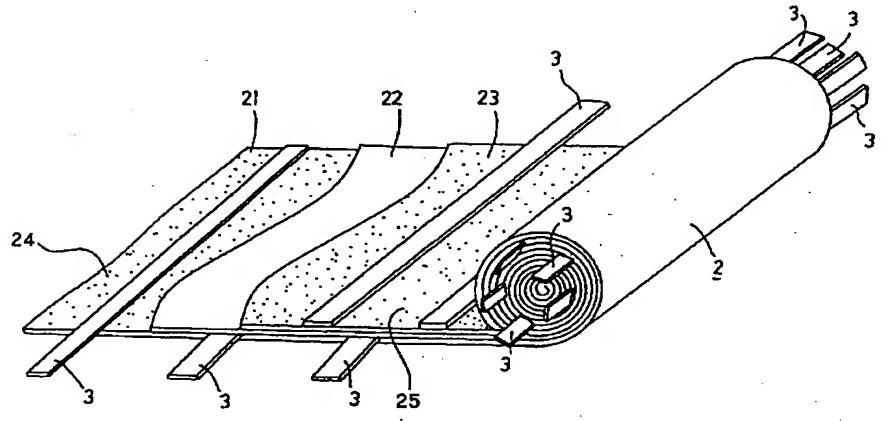

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